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JOURNAL

OF THE

AMERICAN WELDING SOCIETY

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American Welding Society

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AMERICAN WELDING SOCIETY

ESTABLISHED 1919

JOURNAL

Volume 5 November, 1926 Number 11

SUPPORTING THE WELDING SOCIETY

The Society expects to make a determined effort to increase its membership in order to bring it into line with the growth of the welding industry. The cooperation of every member of the Society in suggesting ways and means for increasing this membership and in securing new members is particularly desired. It is the duty of everyone identified with the welding industry to help improve the industry by becoming affiliated with the American Welding Society.

The Society through its national and local section meetings endeavors to combine in suitable proportions, educational, technical and social features, believing that in this way the progress of the industry can best be advanced.

A more expanded grasp of the technical fundamentals underlying our daily problems will be of unquestionable value to all. This information can be secured by combining our knowledge through presentation of papers and through research work. A closer acquaintanceship of the individuals who compose the welding industry through membership in a common organization such as the American Welding Society must lead to better understanding and serve to eliminate much of the destructive influences which are often present among competitive processes and among competitive companies.

Babson's statistical department states that the most deadly competition is between industries and that individual members among a single industry should combine in the conduct of cooperative effort.

The Society plans to expand the field of application of welding in untried regions. This expansion can only be brought about through carefully planned research work and by the whole-hearted support of everyone identified with the Society.

As an organization we have established many important contacts with other industries which will prove of great assistance in our future activities. Before the several welding processes lies a great future; fabrication of large steel structures is just ahead; new markets and new opportunities will be opened up. Much of these opportunities are created by the work of the American Welding Society, which deserves your support by getting new members.

DISCUSSION OF PAPERS

The papers to be presented at the Fall meeting of the American Welding Society have been printed in the October issue of the Journal and distributed to all the members of the Society. Written discussion of any or all of these papers is invited. These discussions should be sent in at once in order that they may be published in the next issue of the Journal.

SIGNED EDITORIALS

At a recent meeting of the Executive Committee of the American Welding Society it was decided to expand that portion of the Journal dealing with Society and the related activities, to include signed editorials by members of the Society on timely subjects of interest to the welding industry. Cooperation of the entire membership of the Society is desired to make this branch of the Journal a success.

If any member has a special message to give to members of the Society or the industry, he is urged to write it up and send it to Society headquarters for publication in the Journal.

RESEARCH DEVELOPMENTS

At the annual meeting of the American Institute of Steel Construction, held in White Sulphur Springs, one

session was devoted to a paper on "Fundamentals of Welding and Their Possible Applications to Steel Structures." This paper was a forerunner of a joint investigation to be undertaken by the American Bureau of Welding and the American Institute of Steel Construction on the welding of structural steel.

A thoroughly representative committee has been organized with Mr. J. H. Edwards, Assistant Chief Engineer of the American Bridge Co., as chairman. This committee will hold its first meeting in Buffalo on Wednesday evening, Nov. 17, to consider a program of research and to discuss ways and means for carrying it out. The cooperation of the whole structural steel industry is expected in making this project a success.

The Welded Rail Joint Committee continues to make active progress. A large number of shear tests have been made to develop a joint plate and method of welding which will give a larger cross sectional area of the welded seams. A number of telemeter readings have been taken to determine the stresses in various parts of rail joints under varying degrees of service.

A joint committee is being organized by the American Society of Mechanical Engineers and the American Bureau of Welding to undertake a scientific study of the applications of welding to the fabrication of pressure vessels. The committee will hold its first meeting early in December. It is expected that the results of these tests will be of assistance to the Boiler Code Committee in drawing up suitable regulatory Codes governing the use of welding in the construction of unfired pressure vessels.

The Welding Wire Specifications Committee has collected a number of samples of good and bad welding wire and this committee is making studies to determine the causes which resulted in these wires being designated as good and bad.

The Bureau also expects to undertake a number of very fundamental studies such as, welds to be subjected to high temperatures; a study of what takes place in the metal arc; nondestructive tests for welds; and conditions giving notably good welds as regards ductility. The American Bureau of Welding is known throughout the civilized world as the unbiased authority for the conduct of welding research. Aside from representatives of the American Welding Society it also has representatives from some 25 other interested scientific and engineering organizations, and is closely identified with National Research Council.

NEW MEMBERS

List of New Members Since Publication of Year Book

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Class B

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John F. Lewis, Welder, Glascote Company, (res.) 3111 E. 126th St., Cleveland, Ohio.

Arthur E. Madson, Electric Welder, Lincoln Electric Company, (res.) 15344 Glencoe Rd., Cleveland, Ohio.

H. F. Remington, Electric Welder, Detroit, Toledo & Ironton R. R., P. O. Box 512, Cleveland, Ohio.

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Andy Schmilt, Welder, American Locomotive Company, (res.) 1601 Seventh Ave., Troy, N. Y.
Leonard M. Smith, Electric Welder, American Locomotive Company, (res.) 10 Yale St., Schenectady, N. Y.

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A. D. Camp, Research Engineer, American Body Company, 2050 Elmwood Ave., Buffalo, N. Y.
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SECTION ACTIVITIES

Western New York

A meeting of the Buffalo Engineering Society and all affiliated sections of the National Engineering Societies including American Welding Society, held a "Management Meeting" under the auspices of the Chamber of Commerce on Oct. 26.

Chicago

Mr. A. M. Candy, Engineer of the Westinghouse Elec. & Mfg. Co., presented a paper on "Some Recent Tests of Arc Welded Structural Steel," at the November meeting held on the 5th at the headquarters of the Western Society of Engineers. Considerable discussion followed the address, and booklets published by the Westinghouse Elec. & Mfg. Co. were distributed to those interested.

Pittsburgh

A meeting of the section was held on the 20th of October, at which time Mr. Robert E. Kinkead, District Manager, Lincoln Electric Co., presented a paper on the subject "Building Machinery for Welding." This was illustrated by lantern slides.

New York

The first meeting of the section was held on Oct. 19. Mr. A. V. Harris of Haynes Stelliting Company presented a paper on "Stelliting—A New Welding Application." The author stated that surfacing steel and iron parts with this non-ferrous alloy adds greatly to the life of parts subject to wear or abrasion. A practical demonstration of Stelliting with the oxy-acetylene blowpipe followed.

The following nominations for officers for the coming year have been sent out by letter ballot:

Chairman—F. E. Rogers, Air Reduction Sales Company.

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Second Vice-Chairman—L. R. Gurley, Railway Mechanical Engineer.

Secretary-Treasurer—A. F. Keogh, Sound Welding Company.

Executive Committee for Three Years—W. R. Hulbert, Metal & Thermit Corporation; F. C. Fyke, Standard Oil Company; J. S. Ely, Third Avenue Railway System; A. E. Gaynor, J. A. Roebling Sons Company.

Cleveland

The first meeting of the Cleveland section was held on Oct. 19, at which time E. W. Green of the Linde Air Products Co. presented an interesting illustrated review of a series of tests made of oxy-acetylene welded roof trusses.

Boston

The first meeting of the Boston section was held on Oct. 21, at which time the members were the guests of the General Electric Co. at their River works plant, West Lynn, Mass. A demonstration of hydrogen and atomic welding and cutting of steel castings by illuminating gas were shown. In the afternoon there were moving pictures and addresses of welcome by N. J. Darling, manager of their river works. Prof. C. A. Adams, director of the American Bureau of Welding, spoke on "Welding Progress Linked with Research." Prof. C. S. Clark also presented an address on "Teaching of Welding in Engineering Schools." P. Alexander talked on hydrogen welding. The last speaker of the afternoon was Mr. C. A. McCune, who talked on "Some Proof That Arc Welding Is Accelerating Production."

A luncheon followed at which members were entertained by the General Electric Apprentice Orchestra and Police Quartet.

In the evening Mr. D. H. Deyoe of the General Electric Company presented a paper on "General Welding." Other papers followed.

EMPLOYMENT SERVICE BULLETIN

Opportunities.—The Society is glad to learn of desirable opportunities from responsible sources, announcements of which will be published without charge in the BULLETIN.

Services Available.—Under this heading brief announcements (not more than seventy-five words in length) will be published without charge to members. Announcements will not be repeated except upon request received after an interval of three months; during this period, names and records will remain in the office reference files.

Note.—Copy for publication in the BULLETIN should reach the Society's Office not later than the thirtieth of the month if publication in the following issue is desired. *ALL REPLIES should be addressed to the number indicated in each case and mailed to Society headquarters.*

POSITIONS VACANT

V-35. Owner of welding shop and radiator company met with accident and desires to sell out; $2,000 cash wanted; very profitable business; will sell building and all for $21,000.

SERVICES AVAILABLE

A-50. Would like to get in touch with reliable firm who contemplates going into the Art of Forge-Lap Welding, for manufacturing Boiler Shells, Chemical Apparatus, Ammonia Pressure Vessels of all descriptions, Pulp Digesters, Air Receivers, Steam Kettles, Car Tanks, etc. Am capable of designing and installing the necessary machinery for either Universal or special manufacture, also of giving instructions with relation to same. I have been thirty years in the profession.

Bound Volumes

Journal of the

American Welding Society—1926

A limited number of copies of the JOURNAL for the year 1926 will soon be available in attractive book form. This bound volume will include subject and author's indexes of all technical papers appearing therein.

As in previous years, these bound volumes are sold to members at $5.00 per copy. A few volumes are still left for the years 1922, 1923, 1924 and 1925.

Orders should be placed at once with the Secretary of the Society.

A New Rail Joint

W. SPRARAGEN

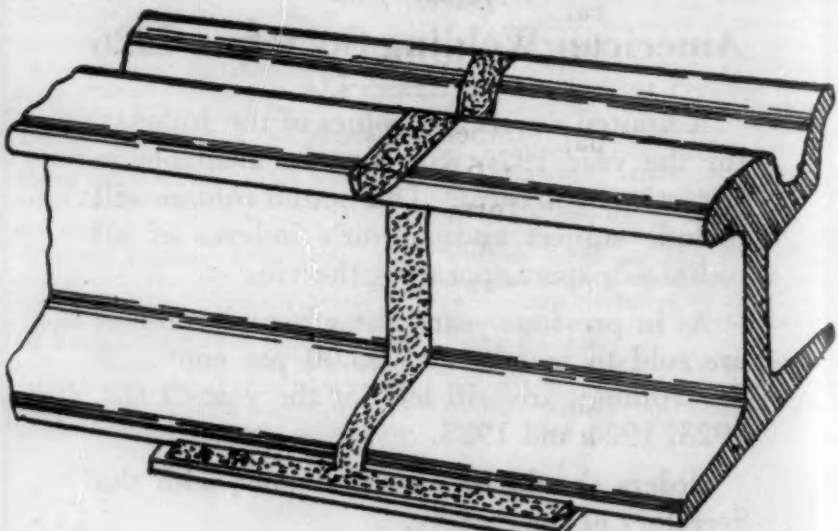
Introduction:

While I am not familiar with the development of the various types of welded rail joints, I can readily imagine that the present form of the "seam" joint now used on the street railways in this country is really making use of modified forms of "fish" plates formerly used in making bolted joints and adding welding wherever convenient. Of course, with the gradual development of this form of joint, experience dictated desirable modifications in the form of fish plates until we now have a wide variety of types in use by the several large street railways of the country.

The substitution of welding in structures designed for riveting or bolting without modifications in the structure itself is, of course, a natural evolution. On the other hand, designing a structure for riveting and merely substituting welding as a fabricating means does not always allow the maximum advantages in favor of welding. Thermit and resistance butt-welded joints are on the other hand not a direct copy of the structures designed for bolted joints. They are especially designed to suit the process for which they were intended. In the joint described below, the author wishes to urge the street railways to try out a new form of joint particularly adapted to metal arc welding.

Description of Joint:

As can be seen from the illustrations, the proposed joint is really nothing more than a straight butt joint made in the rail without the addition of fish plates and with or without the addition of a base plate to give additional strength.



Butt joint for street railway track

The edges of the rail are ground off to form a vee groove from the top in both the head and lip of the rail. This is filled in with the weld metal deposited by the metal arc system. A similar vee groove is made in the base of the rail and in the web of the rail. It will, of course, be somewhat difficult to get a good weld in the web directly underneath the head and lip of the rail. This is not important. Even in this respect the experience gained in pipe line welding could be used to advantage. For example, several sections of the rail could be welded together on the ground in positions favorable to welding and then these long sections could be welded together in the track. If this is done it might be worth the extra expense to provide comfortable conditions for the welder to make good "tie in" joints. Additional strength is given to the joint by welding on the usual form of base plate. Of course, carbon arc and gas welding could also be used in making this joint.

One objection that may undoubtedly be offered by way engineers of the street railway system will be the question as to the wearing qualities of the deposited metal in the head of the rail as compared with the rail itself. For their information, I would like to state that there have been developed electrodes for building up steel rail on the steam railroads and the application of welding to the building up of battered rail ends is now saving several steam railroads hundreds of thousands of dollars annually.

There will not be any necessity of bringing the rail ends together in a tight fit before welding in the above joint. Rails should be aligned carefully before welding and then "tack" welded in several places to hold them together if desired.

Slack in Pipe Lines

L. A. KELLY*

In the following article it is not the desire nor the purpose of the writer to advance figures, theory or practice as irrefutable, but rather the results of study as made over several years in the successful construction of welded pipe lines.

Argumentive and practical comparison may develop a "standard" in rules, analysis and practice acceptable to all concerned, which is sorely needed.

Limited information does not disclose any previous attempt to advance a rule whereby "slack" may be figured to a matter of inches per mile.

However, an attempt to form such a base and prove that contention will be included in article on Amount Necessary.

In the curriculum of pipe line vocabulary appears the word "slack," which is not a new word in general application, but rather a new application to an old word.

Webster defines "slack" as "relaxed or loose, as rope, etc., laying

* Kelly-Dempsey & Co., Tulsa, Okla.

loose;" which is rather hard to apply to the meaning desired in its incorporation as the proper term describing excess pipe displacement.

Applicable to pipe lines, we might define "slack" as the excess amount of pipe above that necessary to form a continuous line.

"Slack" has created a subject of many different opinions among students of welding. For convenience we will divide the argumentive points under the following subject heads:

(1) Purpose. (2) How attained. (3) Amount necessary. (4) Distribution.

Purpose of Slack

Contraction and expansion, nature's power giants, are not to be harnessed by man's proposal. In pipe line construction, man has resorted to pacification in order to overcome contraction. To pacify contraction by distributing an adequate excess over the variable area, thus nullifying line strains, is the purpose of "slack." Where only the proper amount of slack has been provided, expansion finds its own outlet without detriment to bends or welds.

How Attained

The following is the practice generally used in apportioning and holding slack during construction.

Long sections of pipe are placed over the ditch on skids. After the welding is completed, the lowering crew remove the skids and lower pipe to the bottom of the trench. At designated intervals the supports are left across the ditch, which causes pipe to form an "arch" over the skids, and, again continuing on, the pipe is lowered.

These arches are termed "slack loops" and hold a definite amount of slack in reserve, which is not lowered until the work has progressed to a point in advance sufficiently far that the resistence will not permit the excess to creep forward and escape.

The "crotch" is sometimes used in conjunction with slack skids and are placed one on each side near a point where pipe is half way out of the trench. The purpose of this is to distribute the weight over the arch.

In the small diameters, the crotch is rarely used, as the weight is not sufficient to bend the pipe, strain the welds or break the skids, but in the large size crotches are necessary.

To *attain* slack is easy, but to *hold* it to the radius desired requires careful preparation and study.

Amount Necessary

The question is often asked by those interested in pipe line construction, "How much slack is necessary?" The answer has always been evasive with no definite amount suggested.

The practice has been along certain specifications as issued by

one of the large constructors in which the argument was, "Amount necessary an unknown factor; for safety, force in all that the ditch will absorb," and as the regular ditch, common to screw and sleeve lines, would not absorb the quantity desired, these specifications called for a trench twice the diameter of the pipe.

To accommodate this surplus, the pipe was "snaked" from side to side of the trench, which also required that the bottom be flat.

It is the intentions of this paper to question the absolute necessity of wide trenches and flat bottoms in successful pipe laying.

Double width trenches have served a very good purpose, in as much as contraction, as an unknown equation, had to be overcome and wide trenches have been and are confidently accepted as counteraction.

If the successful construction attending the use of the wide trench is proof of its correctness, then the same argument is advanced that just as many successful projects have been placed in normal trenches. If the first suggestion had been for a trench three times the diameter, there would have been no available argument other than—it did not appear necessary, but the exceptional high costs would have been sufficient to discredit it.

Perhaps the added costs are not burdensome on small diameters but consider a construction of 16- to 20-in. pipe which would demand a 32- to 40-in. trench.

If mechanical engineers were unable to figure the strains to which pulleys are subjected and built the hub, spoke and rim with a policy of safety by adding all the metal possible, then truly mechanical design would be of the type of hundreds of years ago.

Progress demands economy which in turn requires the excess be eliminated, whether in pulleys or pipe lines, and if wide trenches are superfluous then they are the means of unnecessary costs.

Width may be of benefit during the excessive heat of summer or as a means of eliminating close supervision, but the contention herein is that a trench which is wide enough to receive sleeve construction is sufficient for welded lines.

A line of pipe, in a wide trench, which is "snaked from wall to wall, has the semblance of an abundance amount of "slack." However, in meeting the requirement of contraction the "push" is limited to the radius or point at which line would be dormant, with further contraction developing a "pull" or line strains.

The wide trench permits the pipe to traverse from wall to wall in long "swells," while a normal ditch will force the pipe in like manner but with short sharp variations; these may be compared to a long and short auto spring in which the driving force of the smaller loop is manifest almost to a point of normalcy, while the larger, longer ceases to function after the release of a portion of the tension due to the absorbtion of the long section and the resistance of a greater area of backfill.

If this theory is correct, then it is evident that the short loops

are under higher tension and will function beyond the longer ones, in which case a normal trench would appear as preferable.

Engineers who champion wide trenches readily agree that during construction in cold weather it is desirable to lessen the amount of slack and consequently the loop radius, which is an admittance that double width is at times, out of season.

Authentic tests have revealed that the movement of pipe at point of loop is barely perceptible during extreme changes, proving that a very small percentage of slack is called into play.

In following these opinions one would surmise that a narrow trench which would not permit "snaking" would be "taboo," yet experience proves otherwise, as properly handled and distributed, "slack" herein is most effective, combining the elements—tension and gravity.

The same procedure of forcing slack within the trench is used with approximately the same amount of slack loops. As lowering of loops proceeds there will occur at intervals a loop which will not go within the limits of the trench, then at points on each side of this loop the pipe is to be raised in a series of small arches, which will be held in position by the "push" exerted one on the other.

It may become necessary, in heavy pipe, to pass a chain under pipe and over skid on a small percentage of these loops, to assist in retaining the arch at a desired point. The pipe will then have the position of being snaked vertically in these arches which will combine the tension and weight in overcoming contraction.

Naturally, this method demands close attention and supervision with temperature and topography as major factors and will be found very effective especially in pipe of large diameters.

Method

The following tables and arguments are not to be considered as an attempt to state how much slack a trench will absorb but how much is necessary to overcome contraction plus amount desired as surplus.

The total expansion or contraction for wrought-iron pipe is equal to 0.805 in. for each 100 ft. every 100 deg. Fahr. change; or in 5280 ft. 100 deg. change equals 42.5 in.

For mild steel pipe each 100 ft. every 100 deg. change equals 0.78 in.; or in 5280 ft. every 100 deg. change 41.2 in. Reducing this we find each 10 deg. change registers 4.12 in. per mile or 0.412 for each degree change.

In computing slack necessary we have the following factors to consider.

(1) Rate of expansion, being the change in inches during change in temperature over a definite footage.

(2) Temperature at time of lowering slack loops represents extreme high temperature, i. e., while temperature may reach a higher point in service expansion elements do not cause trouble.

(3) Extreme low temperature, being the low degree to which line may be subjected during service or low point at which contraction may occur.

Depth of trench, soil composition and local temperature extremes have a divided influence as to service temperature.

Example: On tests conducted by the Bureau of Mines with a 6-in. gas line buried to a depth of 18 in. in Kansas the extremes to which line was subjected during a period of one year was, high 80 deg. Fahr., and low 35 deg. Fahr.

Assuming that line was placed in ditch at a temperature of 65 deg. Fahr. with extreme low of 35 deg. Fahr. we have a service range of 30 deg. Fahr., which applied to rate of contraction per mile of 41.2 in., we have 30/100 of 41.2 or 12.36 in. of contraction to be provided for.

Now if a line had an extreme low of 40 deg. and was placed in ditch at 40 deg. it is evident that resultant expansion and contraction would be equal and the absolute necessity of additional slack questionable, but safety demands that always must there be a reasonable surplus existing, and that surplus must be upward of 100 per cent.

A surplus of 100 per cent in the above application would require a total of 24.72 in. per mile, then it becomes necessary to arrive at a method and figure of knowing just when this amount has been secured.

The method previously described in obtaining and distributing slack readily provides the means of figuring amount deposited within a given area. As these slack loops hold a specific amount in reserve and is not apparent until loops are lowered, then it becomes necessary to ascertain the amount so held.

Depth of ditch and clearance of arch are the factors which specify the amount. Size and flexibility of pipe, together with depth, control the arch, the practical application of which is reduced to the following table (8-in. pipe):

Span Arch Feet	Trench Depth Inches	Slack Inches
100	24	1⅜
120	30	2¼
160	36	3⅛

Now, in the above example, we have a line which requires 24.72 in., let us assume a 24-in. trench, which will require 18 slack loops per mile. A 30-in. trench would require 11 loops.

Each locality presents different problems as to temperature, soil and topography, and proper consideration of these, with depth and other minor conditions, will enable one to arrive at the amount necessary and desired.

Distribution

Distribution of slack is as vital to the success of the line as is sufficient amount, which is controlled by the topography of right-of-way, as every broken contour automatically furnishes slack.

For this reason, each section of line must be assigned the amount of loops which may be absorbed, and not a specified number to be placed per mile throughout the whole line.

Standard practice today becomes obsolete tomorrow and the future methods will, as they arrive, insure construction more economical and enduring.

Advance in Ford Welding Practice*

Ten years ago welding was a process hardly employed in the Ford industries except in connection with blacksmith work. Since then, investigation of its possibilities and adaptation of the process to various phases of manufacture have been rapid. More than two hundred different automotive parts now undergo welding at some point in their production cycle; *more than a thousand men are engaged in spot and butt welding alone;* and the number of separate welds made in these two divisions runs to nearly four million per twenty-four-hour day.

The welding principle is employed in four major forms. These forms, in order of their importance in the Ford industries, are: *spot welding, butt welding,* oxy-acetylene welding, and arc welding.

Spot welding and butt welding both make use of electrical resistance. By using either type, two pieces of metal may be fused together, in a fraction of a second, so firmly that the welded section will withstand a severe strain.

More Than Three Million a Day!

In the Ford industries, 3,378,364 spot welds are made every twenty-four hours on 175 different T-parts. Of these, 1,560,452 are made at the Fordson plant and 1,085,200 at the Highland Park plant, the remainder being divided between the Lincoln plant and the various plants and branches. Seventy-five per cent of the human element has been eliminated from all Ford spot welding by the use of 302 Ford-designed and built spot-welding machines. In all cases the amount of pressure needed and the duration of the current is governed by the machine, bringing about a uniformity of result not achievable by any other means. The efficiency of the welding machines may be judged by the fact that some of them make 35,000 separate welds each per eight-hour shift. The operation of the machines requires 758 men.

The successful development of the Ford wire wheel is due in large part to spot welding. By means of the welding process, a one-piece sturdiness, not present in any other wheel, is imparted to the design.

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*Reprinted from *Ford News*, July 22, 1926.

Butt (or resistance flash) welding is extensively employed in Ford production, and much of the strength with lightness that is incorporated in the structure of the Ford car is due to butt-welded design. A total of 131,043 butt-welds are made of thirty-seven different parts every twenty-four-hour day. The machines used number 104, and they are operated by 260 men. Some machines butt-weld at the rate of 4500 per shift. The total length of the stock butt-welded in a single day is 120 miles.

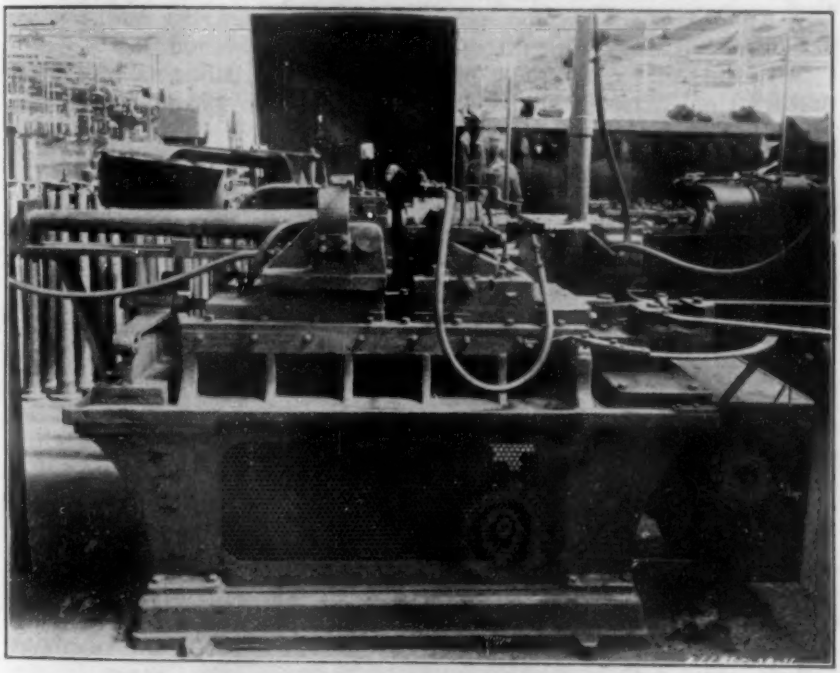


Fig. 1—Butt-welding Lincoln torque tubes on special machine

Such parts as the front radius rods and the drive shaft housing are examples of butt-welded Ford parts. In these examples, light, strong metal tubing is butt-welded to terminal pieces or flanges which have been drop-forged. Other vital parts, in the production of which butt welding is an important factor, are the clutch shaft, the differential ring gear, the starter ring gear, and the starter motor shaft.

Butt welding permits the use of more than one metal in a single part, thus making possible a more perfect adaptability of certain parts to the purposes for which they are intended. The head, and a short portion of the stem, of a Ford valve are subject to intense heat from the burning gases of combustion. It is imperative that these sections be made of a heat-resisting type of steel. The rest of the stem is subject to wear because of its reciprocation through the valve stem guide hole. This portion should therefore be of a

good grade of carbon steel, hardened and ground. By means of the butt-welding process, dissimilar kinds of steel are united in a solid valve ideally adapted to its function.

Ford-Designed All-Steel Piston

The Ford-designed all-steel piston, the only piston of this type in actual production, owes its existence to the butt welding process. A machinable heat-resisting steel dome is butt-welded to a skirt and wrist-pin bushing of steel having a high carbon content, the latter sections being hardened and ground after the welding has been completed. Extreme lightness and long wearing qualities are the chief advantages in pistons made by this method.

All kinds of round stock, pipe, channel iron, I-beams, and much material of intricate shape are butt-welded in Ford maintenance and construction departments.

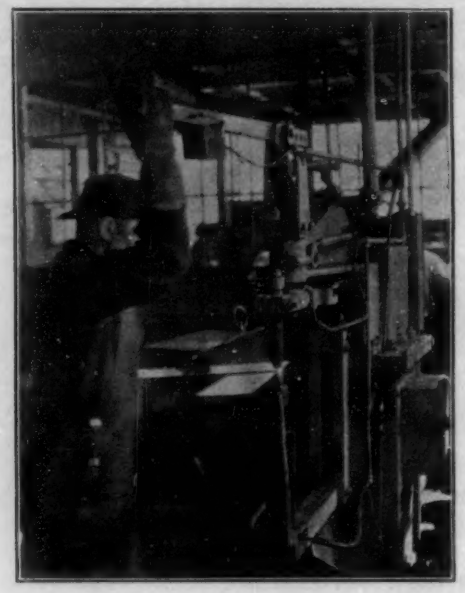


Fig. 2—Spot welding has been developed to a high point of efficiency in the Ford industries. Some machines have a capacity of 35,000 separate spot welds each day

It is possible to butt-weld automatically material from one-sixteenth inch to five-eighths of an inch in diameter; from five-eighths to three inches by hand; and from three to eight inches hydraulically. It takes about 5000 pounds pressure to the square inch to complete a weld.

The next few years will undoubtedly see a much wider application of the butt welding process, and great strides made in the further development of butt welding machinery. The largest butt-welder in the world is located at the Fordson plant; it will weld material up to eight inches in diameter.

Oxy-Acetylene welding, as its name implies, is a process making

use of the intense flame resulting from the reaction of oxygen with some gas containing carbon in a free state. The Ford industries use acetylene because it is easy and safe to handle and because it produces a flame temperature of 6200 deg. fahr., the highest available welding flame temperature. The Ford industries use 138 tanks of acetylene and 271 tanks of oxygen in a single day. About twenty tons of steel welding wire is used per year.

Oxy-Acetylene welding is employed in repairing small defects in cast-iron parts and equipment, such as lathes, grinders, and punch presses. Fifty-five tons of cast-iron filler rod are consumed in cast-iron repairing activities in the course of a year.

Fifty-two miles of pipe lines—including water mains, oil lines, soda water lines, air and gas lines, slag and coal pipes, heating lines, and high-pressure steam lines—are welded together annually throughout the Ford industries.

The cutting torch is one of the most spectacular applications of the oxy-acetylene welding process. By this means a half-inch steel plate a foot long can be cut through in a minute and a quarter, while a piece one foot thick and one foot long can be cut through in six minutes. Five hundred feet is the daily average of cutting in all Ford plants combined.

Arc welding, by which metal is deposited through the "metallic arc" process, is just beginning to be recognized as a form of welding having immense possibilities. Automatic machines for this type of welding are of relatively recent development.

Ford engineers have already adapted the arc method to the production of Lincoln torque tubes, and further applications are contemplated. Thirty tons of welding wire are used every year in arc welding within the Ford industries. Water tanks of from ten to fifteen thousand gallons in capacity are successfully welded by the arc method. Slag buckets, foundry charging floors, traveling conveyor tracks, turbo condenser castings, pipe lines, trolley poles, railroad ties, fence posts, and railroad track all represent instances where the arc welding method has been successfully employed. One hundred and fifty miles of D. T. & I. track have been "bonded" for electrification by this process, and a total of 128 miles of arc-welded seam only, has been laid on Ford pipe lines and conveyor systems in tunnels, power houses, and shops. The carbon arc is being utilized in the jobbing foundry to remove risers from steel castings, and also to cut alloy steels such as nichrome and manganese, at the rate of 2½ tons per day. Carbon arc cutting is being used wherever possible throughout the repair departments.

Ford welding activities are carried on under the supervision of the superintendent's office, and the welding forces are headed by a group of trained mechanics who are always alert to the possibility of advancement in welding technique and welding equipment design. Nearly all the spot and butt welding machines used in the organization have been developed by the company.

The Electric Torch

J. C. LINCOLN*

Several years ago there was developed in the laboratory of this company a piece of apparatus that has been given the name of the electric torch.

Fig. 1 shows the arrangement of the parts making up the torch. The copper electrode holder for the negative terminal is water cooled as well as the copper positive terminal where the path of the cooling water is indicated. The copper anode has a tapered hole cut in it of the dimensions indicated on the sketch. The opening in the anode is round and the dimensions are those of a section through the center of the opening in the anode. Fig. 2 is a plan view of the parts:

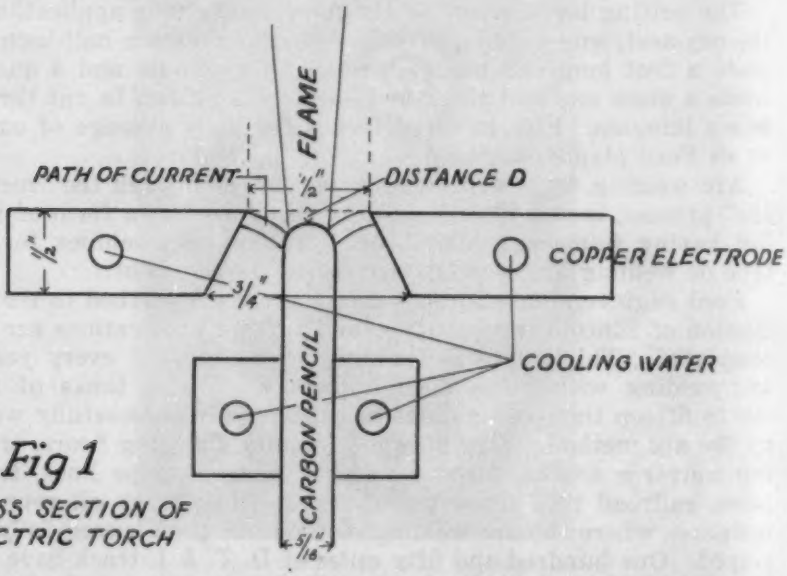


Fig 1

CROSS SECTION OF ELECTRIC TORCH

After the parts are set up, as shown in Figs. 1 and 2, an arc is started between the carbon cathode and copper anode by short circuiting them by a carbon pencil.

The machine furnishing the current was one of the company's 200 ampere welders, and this was adjusted to pass currents of 50, 75, 100 and 150 amperes across the arc as indicated in the table giving the results of a test.

The test was made to find out, if possible, something about the nature of the carbon arc.

Observation of the arc shows that the size of the flame projecting from the anode is roughly proportional to the amperes across the arc as might be expected.

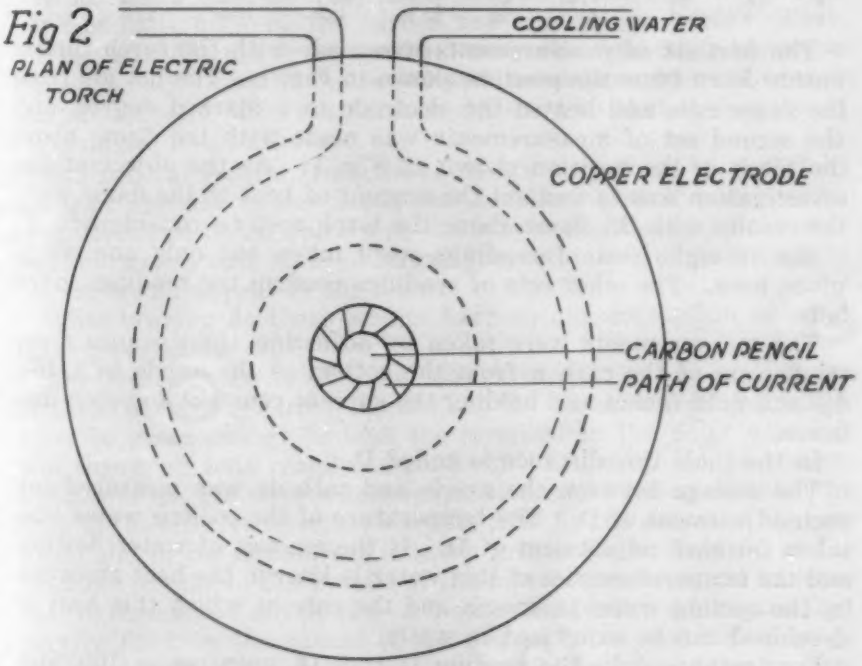
*President, Lincoln Electric Company.

Further, the flame is larger with a given current when the distance D is small and the size of the flame decreases as the distance D is increased.

The difference in the size of the flame with the change of current is much more pronounced than the difference due to changes in the distance D.

The flame is apparently due to very hot carbon particles.

If the flame is cooled, carbon is deposited on the cooling surface as it would be if the flame from a wick is cooled.



The measurements recorded in the table were made as follows:

The valve admitting cooling water to the torch was opened and left untouched during the time the measurements were taken.

The stream of water from the torch was directed into a pail for a period of two minutes before and after the measurements were taken. The weight of the pail was 2 lb. 4 oz. empty. The weight of pail and the water that flowed for two minutes was 13 lb. both before and after the test. Therefore, the amount of water flowing through the cooling system is taken to be (13 — 2¼ ÷ 2 = 5.375 lb. per minute.

The temperature of the cooling water before it entered the torch was 19.10 C.

Weight of pail 2 lb. 4 oz.—weight of pail and water for 2 minutes = 13 lb.

10.75 ÷ 2 = 5.375 lb. water per minute.

Temperature of cooling water 19.10 C.

D. in 1/16	Amp.	Volts	Watts	Temp. of Water After Passing Throught Torch	Temp. Rise Deg. C.	Temp. Rise Deg. F.	B.t.u. per Hr. ÷ 3.41 = W.h. per Hr. Absorbed in Water	Per Cent in Water	Per Cent in Flame
3	50	47	2350	25	5.9	10.6	1002	42.5	57.5
6	50	48	2400	26	6.9	12.4	1170	48.8	51.2
3	75	51	3820	28	8.9	16.2	1535	40.2	59.8
6	75	40	3750	29	9.9	17.9	1695	45.2	54.8
9	75	48	3600	31	11.9	21.4	2020	56.0	44.0
3	100	55	5500	30	10.9	19.6	1850	33.6	66.4
6	100	51	5100	33	13.9	25.0	2360	46.1	53.9
9	100	49.5	4950	35.3	16.2	29.2	2750	55.5	44.5
3	150	57	8560	37.5	18.4	33.2	3130	36.6	63.4
6	150	51	7670	40	20.9	37.7	3560	46.5	53.5
9	150	51	7670	43	23.9	42.9	4040	52.7	47.3

The first set of measurements was made with the torch turned upside down from the position shown in Fig. 1. The hot air from the flame rose and heated the electrode to a marked degree, and the second set of measurements was made with the flame above the torch in the position shown in Fig. 1. As the object of the investigation was to find out the amount of heat in the flame, only the results with the flame above the torch need be considered.

Six or eight sets of readings were taken but only one set is given here. The other sets of readings confirm the readings given here.

The measurements were taken by adjusting the distance from the bottom of the carbon from the bottom of the anode to 3/16-, 3/8- and 9/16 inches and holding the current constant for each distance.

In the table this distance is called D.

The voltage between the anode and cathode was measured for each adjustment of D. The temperature of the cooling water was taken for each adjustment of D. If the amount of water flowing and the temperature rise of this water is known, the heat absorbed by the cooling water is known and the rate at which this heat is developed can be expressed in watts.

For instance, take the reading D = 3/16, amperes = 100, and volts = 55. The temperature of the water after passing through the torch was 30 deg. C. The rise was 30 — 19.1 = 10.9 deg. C. = 19.6 deg. F. The B.t.u. per hour would be 5.375 times 19.6 times 60 equals 6300—as 3.41 B.t.u. per hour equals 1 watt energy was being absorbed by the water at the rate of 6300 ÷ 3.41 = 1850 watts. The energy of the arc was 100 ampere times 55 volts = 5500 watts. Consequently 33.6 per cent of the arc energy appeared in the water and 66.4 per cent in the flame.

It is assumed in the table that the rest of this heat is in the flame and this assumption is justified for the flame is easily capable of melting iron.

The general results of the measurements indicate that the greater the current the greater the energy in the flame and the smaller D is the greater the energy in the flame.

The direction of the flame can be affected by a magnet. By

presenting the S seeking pole of a bar magnet to the arc, the flame is pushed to one side. The flame itself is not affected by the magnet so far as I could judge. The direction of the flame is a function of the current from the carbon cathode to the anode. To put it another way, the magnet had no effect on the direction of the flame unless the magnet was close to the arc between the carbon and copper anode.

The current between the carbon and copper anode is affected in just the way one would expect from the laws governing electric magnetic action.

When there is no external magnetic field at the arc, the current flows radially between the carbon and the copper anode. When the arc is subjected to an external magnetic field, the current is forced to only a part of the radial path between carbon and copper and at the same time the flame is deflected so that it is more at right angles to the current.

The general results from the table are that from ½ to 2/3 of the heat appears in the flame, and I believe that if none of the heat developed in the flame was radiated and absorbed by the copper and water, that an even larger proportion of the total heat in the arc would appear in the flame.

What bearing do these results have on our conception of what takes place in the arc?

The present view is that the voltage across the arc is made up of three portions. First—the drop at the negative terminal which must be great enough to heat the terminal to the point where it will throw off ions readily; second—the I.R. drop due to the resistance of the gas stream between anode and cathode and—third the drop at the positive terminal which is fixed by the nature of the material and in the carbon arc is much greater than the drop at the negative terminal. The results of the measurements would indicate that in the carbon arc there is a drop at the posititve terminal that may be fixed by the nature of the material, but that this drop is not nearly so great as has been supposed. The heat at the positive terminal in the ordinary carbon arc is the sum of the heat, due to the inherent drop and to the heat of the flame or blast from the negative terminal. The heat due to the flame or blast has been separated largely from the inherent anode drop in the electric torch and measured. These measurements indicate that the heat in the flame or blast is greater on the average than the sum of the anode drop, the cathode drop and the I.R. drop, due to the resistance of the gaseous part of the arc.

I do not think it is far from the truth to say that two-thirds of the energy in the carbon arc appears as heat in the flame or blast from the cathode. The question naturally occurs—What is the nature of the flame? Two things can be said of it. First, particles of very hot carbon are shot off the end of the cathode and these draw the air with them so that the flame from a match

is sucked downward through the opening in the anode when the apparatus was set up so that the flame was below the torch. The current of air was doubtless much stronger when the aparatus was turned over, for it was not possible to get the 9/16-in. reading with 50 amperes, for the arc would not persist long enough to permit of measurement of the heat.

I assumed that this was due to the stronger current of air through the opening in the anode when the apparatus was set up to take the measurements contained in the table. The second thing is that the actinic value of the flame near the opening in the anode is very much greater than the value in most of the flame.

A short time photo showed a very small figure on the plate. When the flame was focused on the ground glass the image of the flame covered nearly the whole plate. The pictures were taken in a very short time 1/500 to 1/1000 of a second and at this speed not more than 10 per cent of the flame appeared on the photo that showed on the ground glass plate.

A picture of the flame was taken with the camera behind a piece of $\frac{1}{8}$-in. thick pasteboard to see if the active part of the flame contained X-rays. The results were negative.

When the current was reversed in direction, the apparatus refused to work as a torch and the arc apparently tried to run up the carbon when it was made the positive terminal of the arc. This is a most noteworthy fact for it depends on something beside the electro magnetic forces. In any piece of apparatus with which I am acquainted the direction of motion is independent of the direction of current, for the reversal of current reverses the flux and with both flux and current reversed, the direction of motion is unchanged.

What is this blast or flame from the cathode? Apparently it is not a stream of electrons, for if it were it would be affected by a magnetic field. At the same time it must be remembered that approximately two-thirds of the total energy in the arc appears in this flame. It is my opinion that the blast from the cathode in the carbon arc is due to vaporized carbon from the carbon pencil.

We do not know much about the latent heat of carbon, but it is possible and even probable that it is very high. If I am correct in the opinion that most of the energy of the carbon arc is expended in vaporizing carbon from the carbon cathode and that most of the heat that appears at the positive anode is due to the solidification of the vaporized carbon at the anode, this would be evidence of a large amount of energy required as latent heat to vaporize carbon.

It is my belief that to get a more accurate conception of what occurs in the arc, we shall have to substitute the idea of the blast from the negative terminal as being the central and important

thing that occurs in the arc, for the idea that there are inherent anode and cathode drops.

The tests described in this paper show that the flame is a phenomenon associated with the negative terminal.

The old way of looking at it would be to say that the inherent drop at the positive terminal was great enough to produce the heat that actually appears there. This old conception has, I think, been shown to be wrong by these tests.

The old idea was that the current passed across the arc in a solid stream and that a cross section of the current in the arc would be a circle.

The experiment with the torch as well as some others not described indicate that the core of the arc is the blast from the negative terminal and that the current flows outside of the blast and that the section of the current across the arc would be an annulus and not a circle. In such a cross section the inner circle would be the cross section of the blast from the negative terminal and the annulus outside of this inner circle would be the cross section of the current. There is no doubt that this is the true picture of the cross section of the current in the case of the torch, and I believe it is the true picture in any carbon arc.

Ultimate Strength of Single Vee Welds

E. E. THUM*

Such a good account of themselves has been given during the past twenty years by millions of gaswelded joints, establishing a reputation for strength and reliability, that the engineer and designer has begun to ask himself "Just how strong is a weld, when made under procedure control?" "What figures should I use in my designs, so I can be assured of safety as well as economy?"

Several attempts have been made to answer these questions, and the results have been published from time to time. Unfortunately, such investigations have been too brief and of too limited scope to warrent an unreserved acceptance of the findings. Usually only one or two workmen did the welding, and the results naturally would be unduly influenced by the individual's skill, the materials he used, and other circumstances of the test.

Just as the oxy-acetylene process warrants more and more confidence as satisfactory experience with it accumulates, so the results of a series of engineering tests become of more and more general application and acquire a higher and higher degree of accuracy, as the influence of accidental variations become submerged in a great mass of data. To know something about the skill of 100 welders is of much more value than to know that an occasional workman can do most excellent work. Averages of

*Manager, Technical Publicity Dept., The Linde Air Products Co.

results gathered from 50 shops scattered all over the United States are almost sure to eliminate the influence of sporadic variations in practice, one way or another. Continual testing over a period of years prevents the possibility that the workmen were keyed up to unusual efforts.

Such a test (almost ideal) has been completed by Union Carbide and Carbon Research Laboratories. Operators employed in various railroad shops in the country, 75 or 80 in number, were tested at intervals. From 1920 to 1923 the welding rod used was that known commercially as "Norway Iron," really a first-class low carbon steel. During the last three years a rod known as "High Test Rod" (containing about 0.20 per cent carbon, high in silicon and manganese) was the standard.

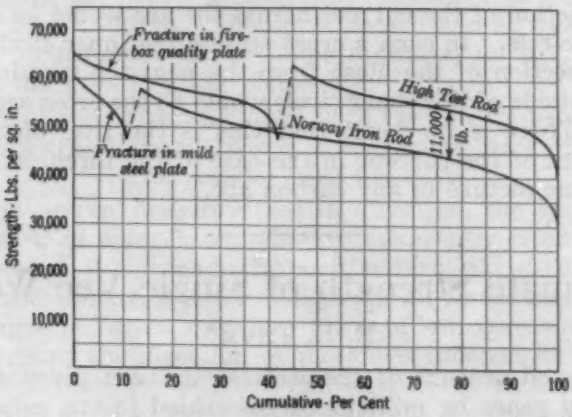


Fig. 1—Results of tests

Pieces of plate about a foot long were taken from railroad stock, welded in the course of regular work with a single vee butt weld, the plate sent to the laboratory, where it was cut into strips, all reinforcement ground off so the weld was exactly equal in thickness to the plates it joined, and the strips then pulled apart in a tensile testing machine. These tests, of which there are about 500, are segregated into those which broke the plate, and those which broke the joint. The individual results are plotted in Fig. 1 in order of decreasing magnitude. Horizontal ordinates represent cumulative per cent of total.

The early three years on Norway Iron showed that only about 11 per cent broke the plate, which was supposed to be of good quality (and which actually averaged 53,000 lb. per sq. in.). In later work on High Test Rod, it was found immediately that only the best of flange steel should be used for test metal; even so, nearly half the specimens broke the plate rather than the weld! Fig. 1 also shows without doubt the influence of high quality welding materials. Men of all grades of ability are able to increase the strength of joint by some 11,000 lb. per sq. in., merely by using

better welding rod. Since the least skillful man is the shop's weakest link, so to speak, this is a most important consideration.

A measure of the reliability of oxy-acetylene welding, when done by men selected with reasonable care, and working under the principles of procedure control, may also be gained from Fig. 1. Note that nearly half the test pieces made in the last three years broke the plate rather than the weld. Note also that the variation in ultimate strength of the best to the poorest weld is hardly greater than the corresponding figures for the plate. But remember that this plate is fire-box steel, a material purchased under rigid specification and representing the highest quality available—mate-

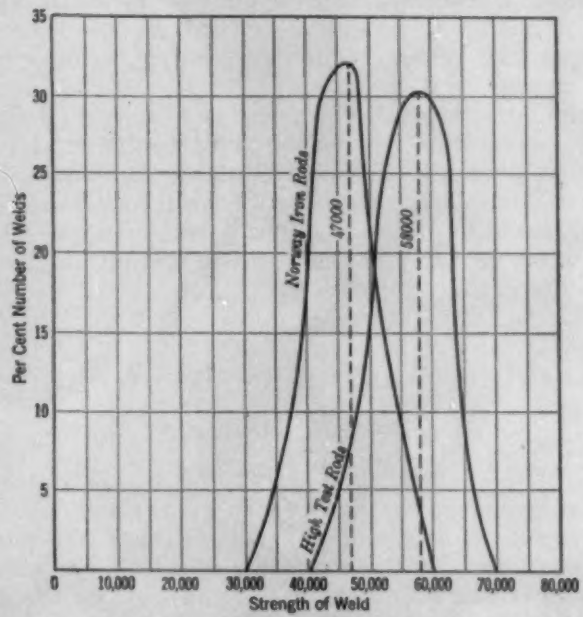


Fig. 2—Most probable average ability of welders

rial above suspicion and used for the most exacting service in locomotive boilers. Yet procedure control oxy-acetylene welding is here demonstrated to be equal in quality.

One question yet remains to be answered. From this mass of data, what figure should be selected as representing the average tensile strength of weld metal, a safe figure to use for design purposes. It would be as unfair to use the lowest value reported as it would be to use the highest value, or for that matter to assume that fire-box quality steel should be figured at less than 50,000 lb. per sq. in. (since one of these test specimens broke the plate at that low figure). Mathematicians answer such questions as these by replotting the data in the form of a "probability curve," as in Fig. 2. The number of test pieces which falls within a certain range is plotted vertically at a distance to the right representing the mid-point of the range in question. The peak of such a curve

represents the most probable value; if it varies much from the theoretical shape its form suggests undue influence of disturbing factors.

In plotting Fig. 2, the strength of joint in those pieces which broke the plate was assumed to be 5,000 lb. per sq. in. greater than the strength of the unwelded plate.

It indicates that the expected strength of single vee oxy-acetylene welds, all reinforcement ground off, and made by operators selected with reasonable care, is as follows:

Using Norway Iron Welding Rod, 47,000 lb. per sq. in.

Using "High Test" Welding Rod, 58,000 lb. per sq. in.

These figures represent, with a high degree of probability, the strength of good joints, and designers can use them with confidence when they specify procedure control welding by the oxy-acetylene process.

The factor of safety selected from each individual design would take into consideration the poorest joint in the lot; but for either variety of welding rod, this is well above the elastic limit of low carbon steel suitable for welding. Therefore, elastic limit of the base metal would be the ruling consideration in the selection of a factor of safety to apply to the ultimate strength of the joints described in the paragraphs above.

Building Machinery by Welding*

ROBT. E. KINKEAD†

Welding a New Engineering Practice

Mechanical engineering has had to go through a very radical evolution since welding and gas cutting have become practical shop methods. Two of the most important things we do in mechanical engineering have been greatly affected by the widespread use of welding and cutting. The mechanical engineer today who does not understand these two metal working methods is as hopelessly handicapped as if he did not know the multiplication table.

The two fundamental problems I refer to in mechanical engineering, which have been so strongly affected by welding and cutting are:

1. Getting metal into a predetermined shape.
2. Fastening pieces of metal together into a predetermined assembly to make a piece of machinery or equipment.

Whether one undertakes to build a steam locomotive, an electric farm lighting outfit, a printing press, or a kitchen stove, these fundamental problems must be solved.

Great industries have been built up on the strength of people's idea of the proper solution of these problems. For instance, the

*Presented at Pittsburgh and Philadelphia Sections, A. W. S., in October, 1926.
†Lincoln Electric Company.

whole foundry industry of this country is founded on one idea of how to get metal into a predetermined shape. Gray iron, steel and malleable foundries exist to solve this problem. Now a whole set of industries are founded on an idea of how to put pieces of metal together in an assembly. Take for instance the matter of rivets and bolts. Great plants in this country do nothing else but make bolts. Back of those plants are other plants which make nothing else but automatic machinery to make bolts.

The point I wish to make is, that the problems with which welding and cutting deal, are fundamental mechanical engineering problems which underlie the manufacturing industries of this country. I want to also make the point that no process ever introduced in this country, ever produced such sweeping changes in industry, as welding and cutting are about to make.

Operation of Economic Law Forces Use of Welding

The reason these changes are taking place now, and will take place at a tremendously increasing rate from now on, is, that welding and cutting have introduced a BETTER means of doing the work, and a method which is TREMENDOUSLY CHEAPER. The operation of economic law makes it necessary to adopt methods which are better and cheaper. New manufacturing institutions are forging ahead to financial prosperity, because they have in this respect aligned themselves with the operation of economic law. Great manufacturing institutions whose managements have fallen into mental ruts from which they cannot rise, will inevitably fail and be wiped out of existence. Economic law does prevail. You may evade the Prohibition Law, but no one has ever evaded the operation of economic law. Ignorance of the laws of economics will not mitigate the penalty for disobedience, any more than ignorance of the law of gravity will mitigate the penalty for jumping out of an airplane without a parachute.

Here is what this new mechanical engineering practice of using welding and cutting enables us to do. We can take hot rolled steel, which costs around 2c. a pound, get it into the proper shape, and fasten it together by the use of welding and cutting for ½c. to 1c. per pound. Let us say that the equivalent of a rough gray iron casting costs six cents a pound. Owing to the superior strength and stiffness of steel, we only have to use half as many pounds as if we were using cast iron. Therefore, a 100 pound casting which costs $6 may be reproduced in welded steel for about $1.50.

Now let us see how that works out as a business proposition. Suppose a machinery builder is making a machine which has 2000 pounds of gray iron castings on it, which may be reproduced in welded steel. At 6c. a pound the rough casting would cost $120. Another machinery builder starts up to build the same machine from welded steel. The same piece costs him only $30. This difference of cost appears in the ratio of at least three to one in the

selling price. The manufacturer using the gray iron castings will therefore have to sell his machine for at least $270 more than his competitor, if he is to break even with him. Now there are not very many standard machines which sell for more than 30c. a pound. Gas engines, pumps, compressors, machine tools, etc., sell on the market for less than 30c. per pound as a general proposition. At 30c. a pound the manufacturer would get $600 for his machine made of gray iron castings and weighing 2000 pounds. His competitor using welded steel can sell his machine for $270 less and make the same profit. His competitor's price would be therefore, $330. Other things being equal, who will get the most business? You may not think you know much about the operation of economic law, but if you know the answer to this question, you know a good deal about it.

Cashing in on Your Knowledge of Welding

I suppose that I shall be severely censored by the intellectual giants of the engineering profession, if I, an engineer, say to you, that you can make a lot of money out of showing people how to build machinery out of welded steel in place of gray iron castings. Engineers are not supposed to talk publicly on the subject of making money. From the high power engineering viewpoint, that is a very vulgar subject.

But I will try to bear up under such criticism as may be directed at me for talking to you on the subject of making some money out of your welding knowledge.

If you want to make some money out of a proposition, don't wait until everyone else knows about it before you start. That holds whether you are buying real estate, stocks and bonds, or anything else which you do with the expectation of profit. Take radio, for instance, if you expect to be anybody, get anywhere or make money out of radio, you should have started about five or six years ago. Everyone knows that radio is a good thing now. The fellows who cashed in on it knew it five or six years ago, and that same principle holds in the welding industry. If you want to cash in on your knowledge of welding today, don't start into the tank welding business, everyone knows that it is a good proposition, and there is no money in it for beginners.

Welding Machinery Parts

Before welding amounted to very much in the commercial field, the steel industry took a very important step, the effects of which are now becoming apparent in the welding industry. Those steps were:

1. Organization of the Steel Corporation.
2. Mass production of standardized shapes and sections of steel.

The result of those two movements in the steel industry amounts

to this. Steel today costs around 2c. a pound, while cast iron costs around 6c. a pound on the average. Steel is four times as strong as the best available cast iron, and is more than twice as stiff for the same section. This means if you want to make a machinery base where stiffness is the determining factor, the material cost of using steel is one sixth the cost of using cast iron. Welding offers a means of putting together the pieces of steel in such a manner as to get the desired shape of piece. The cost of welding together steel pieces is so low that practically the whole saving is effected due to the lower cost of the steel as compared with cast iron. Until electric welding became commercial, it was not possible to put the pieces of steel together to get the desired piece without using up all of the saving which had been effected by the use of steel in place of cast iron.

This situation is amazing. Steel which sells for 2c. a pound was pig iron before it was steel. Yet gray iron castings, which are merely refined pig iron, cost around 6c. a pound, and it takes four times as many pounds of pig iron to get the same strength as we have in steel.

Why does any one manufacturing machinery use gray iron castings? The reason is perfectly simple and is the same that made tank builders rivet tanks together until the welding industry showed them how to make better tanks for less money by welding. Machinery builders do not know how to weld steel pieces together to reproduce rough castings in welded steel. If they knew how to do it they would be doing it now.

Now don't forget, gentlemen, that most of us do not readily agree that we do not know how to do anything. If you explain to the average machinery builder how the savings are made, and why they are made by using steel in place of cast iron, he will not fall on your neck and call you blessed. The chances are about three to one he will tell you that you are slightly demented and say that if those things were true every one would be doing it. It is human nature to do that very thing. The man's trouble is that he does not see how he can apply the method to his particular job and until someone shows him he will not budge an inch until something stronger than a lot of words hits him. Let one of his competitors do it and whip him in the field a few times and the machinery builder will come to you hat in hand and beg you to please help him do the job. That very thing is going to happen. The welding industry will not be able to furnish enough men to direct the welding operations along these lines. A good many men of intelligence and imagination in the welding industry who are makig $2,000 a year today will be making $10,000 a year in five years.

Preparation for the Work

Now I am going to suggest to you how you can start getting ready to make $10,000 a year out of your welding knowledge.

Start studying the machinery built by some machinery builder right here in your own town. Pick out a definite job to work on. A machinery base or frame is the easiest and simplest thing to go at first. Study out how you could take standard steel shapes, plates, etc., and weld them together to produce essentially the same piece. Next, check the design to see that you have given only equal stiffness. This will keep the weight down to about one-half the weight of the casting. Next check the welding to see that you have not specified unnecessary welding to accomplish the purpose. Next check the design to see that you have not done the job in an awkward manner, which penalizes you on the cost. When you get to the point where you are satisfied with the job, you are ready to show that machinery builder something. Remember, you haven't invested anything, you haven't spent a dime. All you have done is to put some of your welding experience down on paper where it is possible it may be worth a lot of money to you as well as the machinery builder involved. Don't be discouraged if nothing happens when the machinery builder sees your plan. Sit tight awhile, and you will find that he will come around looking for you.

There are twenty big machinery builders in the country right now who would welcome the opportunity to take on a first rate welding man with the intelligence and imagination to do this job for them, starting right now. As soon as the welding men appear who will apply their talents to this job, every one in the country is going to want to do the same thing, and there will not be enough men to go around. But the fellows who get in on the proposition first are going to get into the $10,000 a year class first and quickly.

Please remember, that the suggestion I am making to you does not involve investing any money, does not involve learning a new business, but does involve staying up at night for awhile studying how to apply what you already know.

High Power Technical Knowledge Not Necessary

I have seen good welding men who were afraid to tackle this proposition, because they thought a working knowledge of structural steel engineering would be necessary to get successful results. After looking into this phase of the situation pretty thoroughly I am convinced that such is not the case, for the following reasons:

1. Very little machinery which is built today was designed by a man who had a working knowledge of structural cast iron design.
2. Castings are designed by cut and try methods. The engineer guesses about what the thickness and weight should be and adds on 200 to 300 per cent for factor of ignorance and lets it go at that. If the casting is too light he makes the next one heavier.
3. If the casting gives satisfactory service, we know that if

we design the steel piece for the same stiffness, we will be safe.

In a machinery base, stiffness is the determining factor in most cases. Therefore, if we reproduce a casting in welded steel, we may expect the welded steel base to weigh about one-half as much as the casting. If the base is properly designed, the holding down bolts merely keep the base from moving in a horizontal plane on the foundation. There is no force tending to lift the base, and the weight of the machinery mounted on it tends to hold it down. The force tending to make the base move in a horizontal plane on the foundation comes entirely from vibration of the machinery mounted on the base. This force is so slight that very light lugs attached to the side members by welding may be used. The practice of making the nuts on the holding down bolts bear on the main beam section of the side members came about largely, due to the fact that in the design of cast iron bases, light lugs cannot be used due to the inherent weakness of cast iron. As a result of this practice, followed in cast iron, the whole machine base is designed heavy enough so that with the biggest wrench which can be applied to the nuts on the foundation bolts, and the biggest man pulling the wrench, the base cannot be distorted. The main purpose of the base is frequently lost sight of in an attempt to prevent distortion by the holding down bolts.

No intelligent welding man who will use his common sense need have any hesitancy about redesigning a machinery base for welded steel. A very casual study of how cast iron bases are designed will convince anyone that there is room for a lot of improvement.

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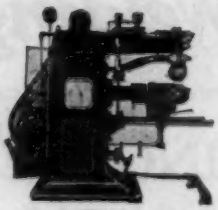

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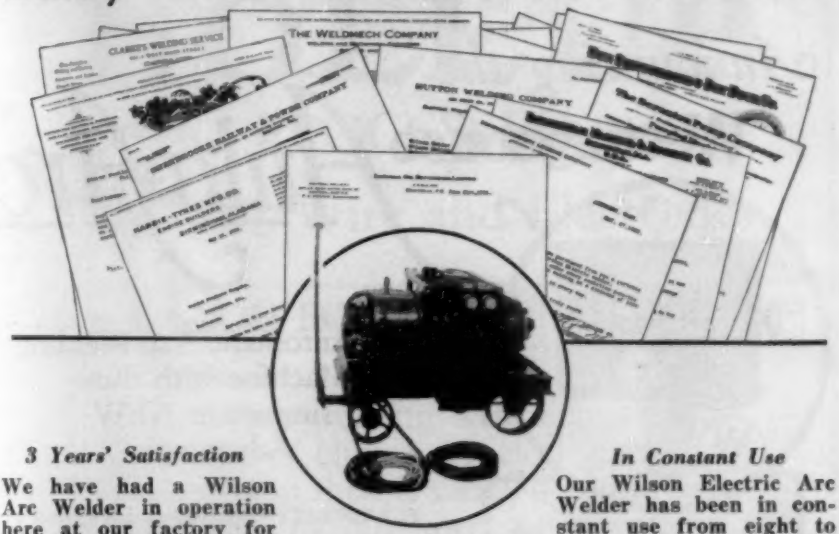

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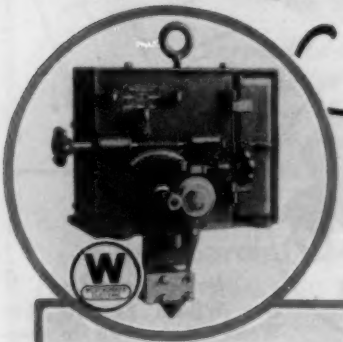

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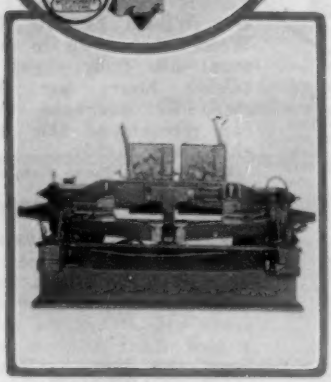

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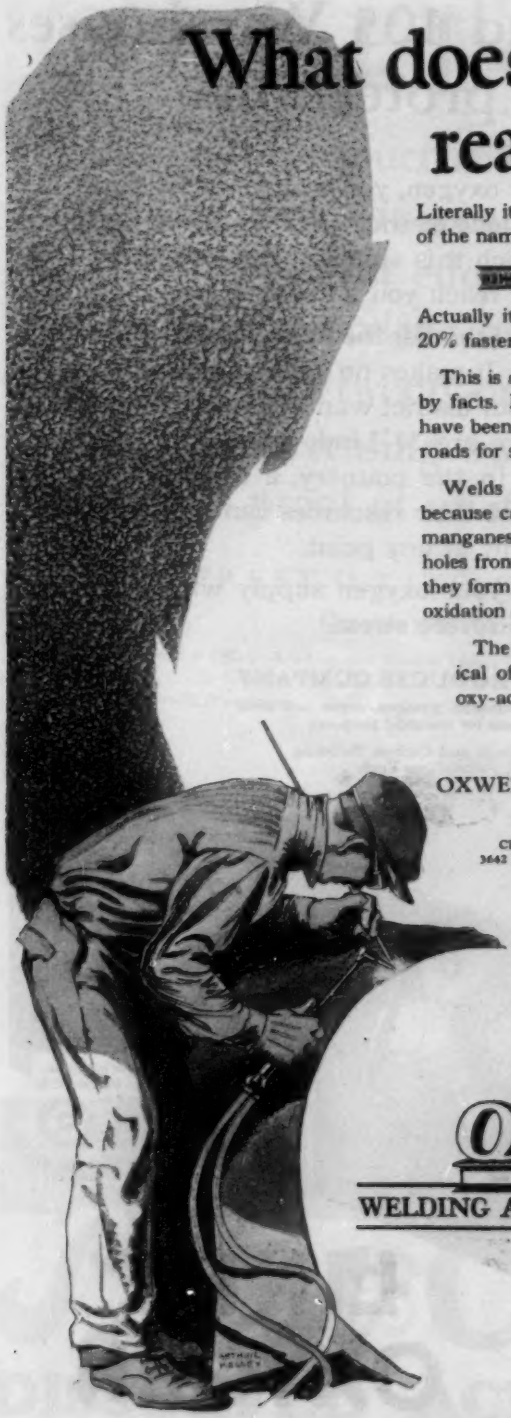
This is a broad statement but it is backed by facts. For over three years these rods have been used very extensively by the railroads for steel welding.

Welds of greater strength are possible because carefully proportioned quantities of manganese and silicon prevent gas blowholes from weakening the weld. In addition they form a thin layer of slag that prevents oxidation of the weld.

The development of these rods is typical of Oxweld's service in making the oxy-acetylene process increasingly useful.



OXWELD ACETYLENE COMPANY

LONG ISLAND CITY, N. Y.
Thompson Ave. & Orton St.

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3642 Jasper Place

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Oxweld

WELDING AND CUTTING APPARATUS

Most Boiler and Tank Manufacturers Use G-E Arc Welders

HENRY VOGT MACHINE CO

LOUISVILLE, KY., U.S.A.
Jan. 5, 1926.

General Electric Co.,
455 So. 4th St.
Louisville, Ky.

Attention Mr. H. H. Hughes, Sales Agent.

SUBJECT: Arc Welders.

Gentlemen:

In response to your letter of the 23rd ultimo wish to state, we have been using your arc-welding machines for the past five or six years in welding caulking seams on high pressure and high temperature vessels, and have found these machines as regards to operation and the quality of the work performed satisfactory to our customers and ourselves.

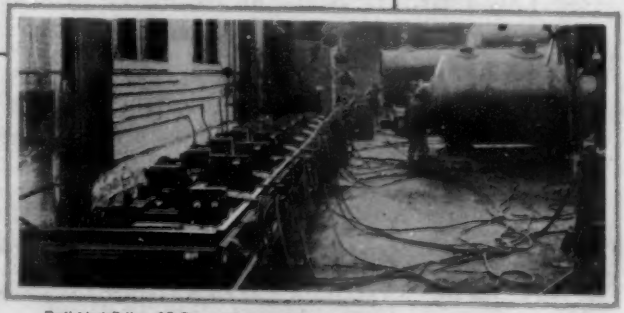
You may be further interested in knowing we have considerably cut the cost of our welding operations since we began using your machines.

Yours truly,

HENRY VOGT MACHINE CO.
H. EV Vogt,
SUPERINTENDENT.

KEV (HS)

Vogt high pressure and high temperature oil stills—10 ft. diameter 40 ft. long, weight 107,000 pounds. Four welders working from G-E Type WD arc welding sets



Partial installation of G-E arc welders used for welding high pressure gasoline stills in plant of Henry Vogt Machine Co., Louisville, Ky.

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WD Arc Welders—designed for one operator
Constant Potential Sets—for several operators
Arc Welding Resistors—for mining and traction companies
Automatic Sets—for repetition work

Complete information and bulletins available at your nearest G-E office.

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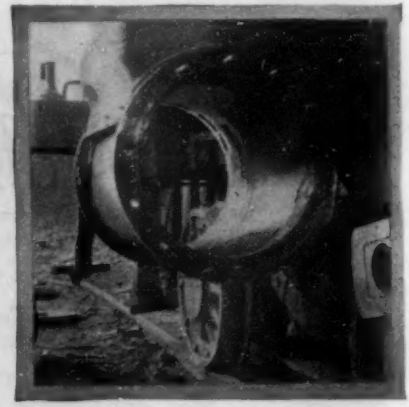

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By using Tobin Bronze, the broken flange was welded in place at a red heat, with the Oxy-Acetylene flame, without dismantling the casting, at a great saving in time and expense. And the weld is stronger than the original cast iron.

Tobin Bronze Rods, an exclusive product of The American Brass Company, can be secured from leading Distributors.

Descriptive pamphlet, including table of weights, melting points, also suggestions for welding with Tobin Bronze, sent upon request.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: ANACONDA AMERICAN BRASS LTD., New Toronto, Ont.

TOBIN BRONZE

REGISTERED U.S. PATENT OFFICE

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Before you settle on the type of machine get the users viewpoint

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(a new list in each issue)

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* * *

"I might add that we are very well pleased with the welder. In its service, it has given entire satisfaction and practically no trouble."

* * *

"We have found these machines highly satisfactory as to performance and upkeep. In addition to this we have found that the average worker can operate these machines and turn out an excellent grade of work."

* * *

"I have had twelve years' experience with arc welders of different makes, but I always stand by the Lincoln."

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"In my many years' experience as welder and in charge of welding jobs, I have never known a Lincoln salesman or representative to state anything but the most conservative facts about their machines and supplies."

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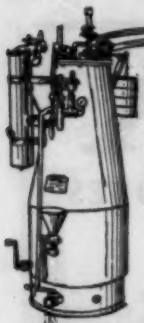

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Heat treating the weld metal by the UNA Process offers a simple, practical method of increasing the strength, ductility and resistance to impact of the weld.

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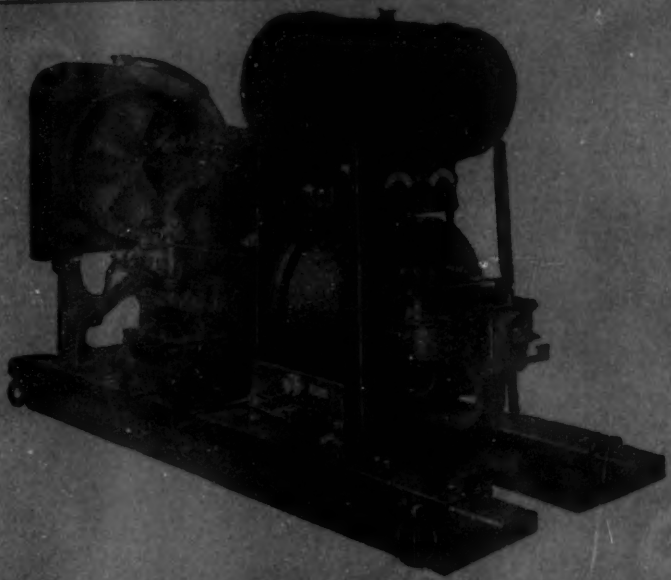

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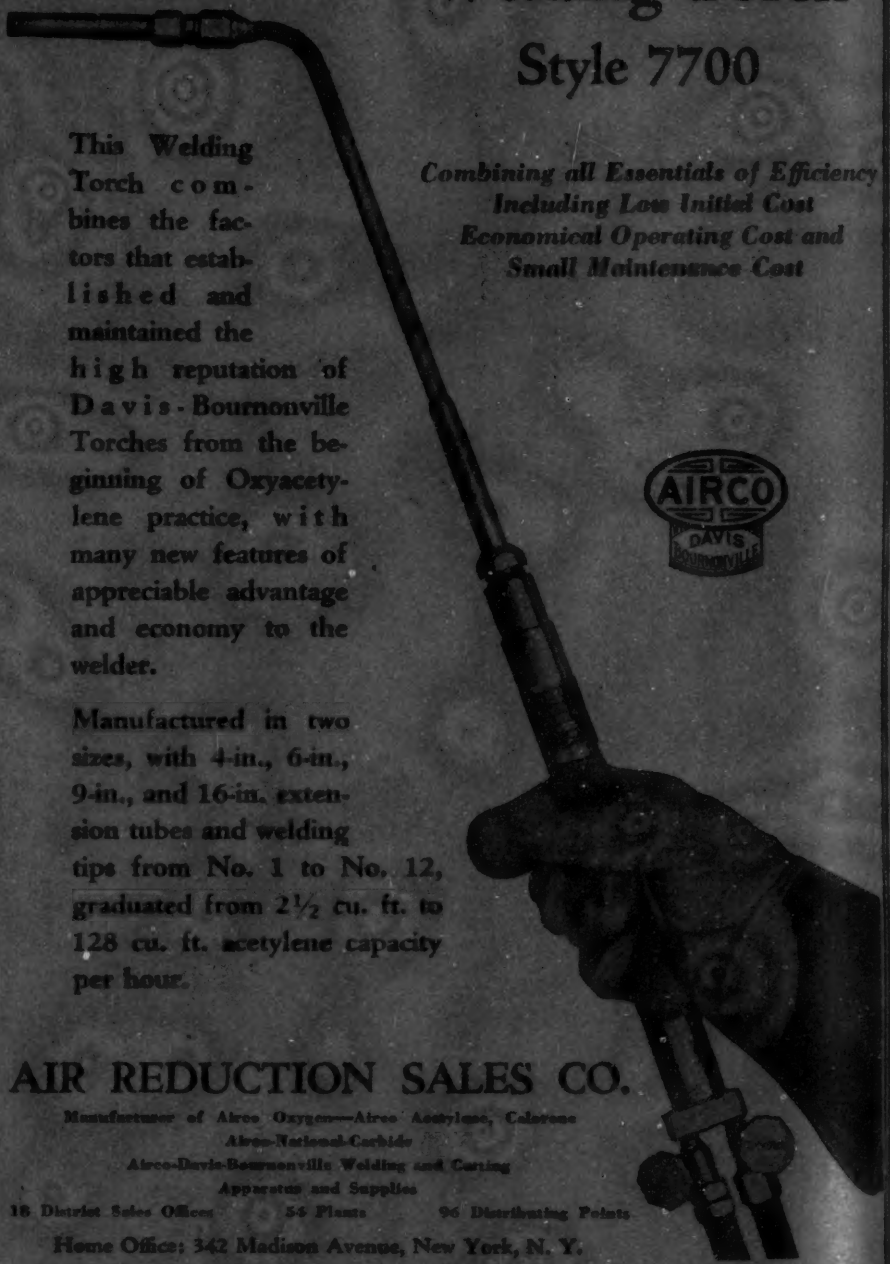

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